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## TECHNICAL MEMORANDUM

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**TO:** NANCY RUMRILL, EPA  
**FROM:** Doug Bartlett  
**SUBJECT:** Proposal for multi-level monitoring study, Gunnison Project  
**DATE:** July 11, 2017  
**CC:** REBECCA SAWYER, STEPHEN TWYEROULD, ALISON JONES

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EPA has been reviewing Excelsior Mining Corp.'s Underground Injection Control (UIC) application and providing comments. One comment that was offered by EPA's outside technical reviewer, Mr. Jim Walker, was that Excelsior needed to include multiple sensor probes for specific conductance (SC) in intermediate monitor wells (IMWs) such that changes in SC can be observed at different depths in the IMWs. Mr. Walker's concern is that if only one SC probe is included in each well as Excelsior has proposed in the UIC application, an excursion of mining solutions intersecting the well in a fracture located some vertical distance from the probe would not be detected. Excelsior understands but does not necessarily agree with this concern and is also concerned with the cost of installing multiple probes in each IMW. To evaluate this issue, Excelsior would like to propose a study during the first few months of mine operations. This memorandum and the attached figures provide a description of Excelsior's proposed study.

Excelsior plans to install both inner and outer IMWs. The set of inner IMWs will be used by Excelsior to monitor injection/recovery operations and are expected to show the presence of mining solutions as injected solutions "sweep" through the mining area and the immediate surrounding rock. Outer IMWs will be used as an early warning system to monitor excursions of mining solutions away from the mining block prior to those solutions reaching the surrounding hydraulic control wells. Because the inner IMWs are expected to encounter mining solutions, Excelsior proposes to test multiple SC probes in several of the inner IMWs. Of interest for this test is whether a detection of increased SC occurs in all probes simultaneously or whether one or more of the probes in a well remain at background SC even after another probe in the same well shows an increase above background SC.

Figure 1 is a depiction of the Year 1 mining block, the locations of key faults, and the locations of both inner and outer IMWs. Two east-west cross sections are also included on the figure showing the locations of IMWs in relation to dipping structures. Excelsior has selected three inner IMWs to conduct tests using multiple-depth probes; NSM-06 to the north of the Year 1 mine block, and NSH-19 and NSH-24 south of the mine block. Excelsior evaluated fracture intensity logs from each of these wells and selected several depths to place SC probes. In general, probe locations were selected to represent both intervals with intense fracturing and intervals with less intense fracturing in the same well. Fracture intensity logs of these wells are provided in Figures 2, 3, and 4 for NSM-06, NSH-19, and NSH-24, respectively. Table 1 provides a list of the wells and the proposed depth placements of SC probes.

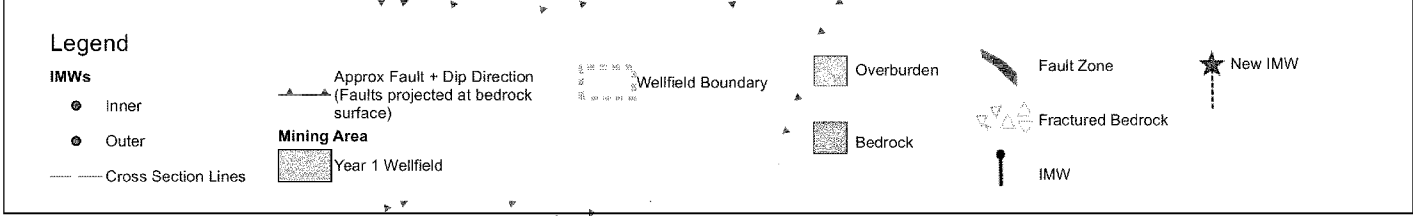
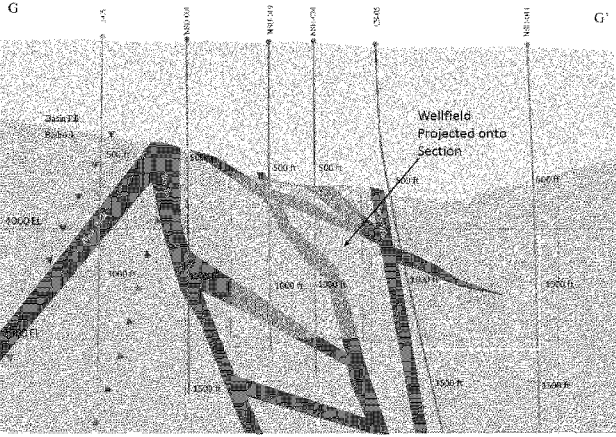
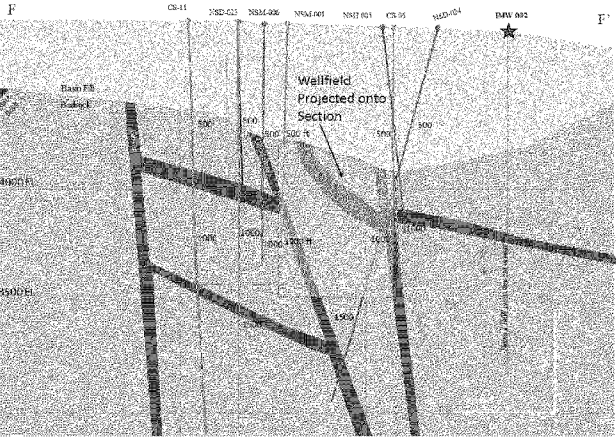
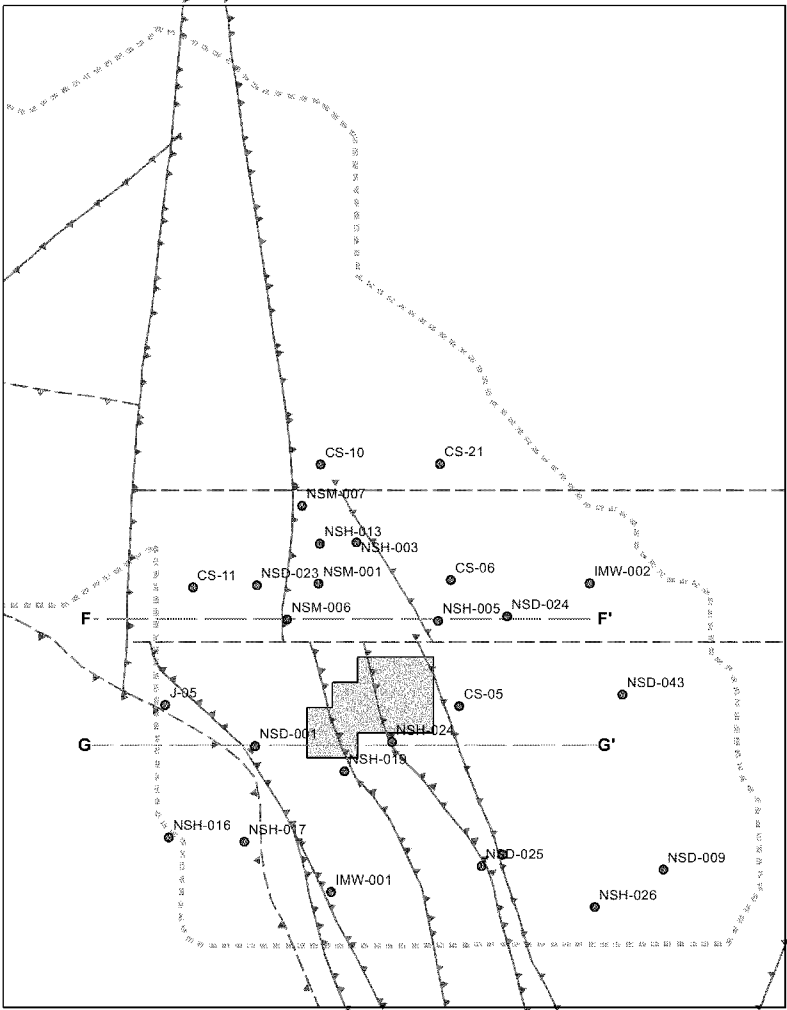
**Table 1**  
**Proposed Probe Depths**

<b>Well Name</b>	<b>Depth to Water (ft)</b>	<b>Probe Depths (ft)</b>	<b>Total Depth (ft)</b>
NSM-06	~632	780, 870, 1070, 1270	1217
NSH-19	~603	800, 1000, 1180, 1280	1373
NSH-024	~603	730, 970, 1170, 1270	1442

In all of the inner IMWs, the upper probe will include both a 100-psi pressure transducer and an SC probe.

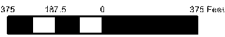
The probes will be installed prior to mining operations to allow measurement of ambient conditions. Probes will be programmed to measure pressure and/or SC every 6 hours. Data will be downloaded from the probes once per week. After 4 months of operations, Excelsior will compile the data and provide a technical memorandum to EPA/ADEQ regarding the findings of the study and will make recommendations regarding the use of single versus multiple depth probes in the outer IMW wells. Note that outer IMWs will have one pressure transducer/SC probe installed prior to and during all operations as described in the UIC application.

The key observation will be whether increases of SC above ambient occur in all probes within a short period of time (hours to a few days). The measured value of SC above ambient is not particularly important, but rather the detection of a change in SC consistent with the influence of mining solutions. Variations in SC between probes is expected. Because SC is just being used as an indicator, the test will be whether detections of a change happen approximately concurrently in all downhole probes.



Excelsior Mining Arizona Inc.  
Gunnison Copper Project  
Date Revised: 7/10/2017

Coordinate System: NAD 1983 StatePlane  
Arizona East FIPS 0201 Feet



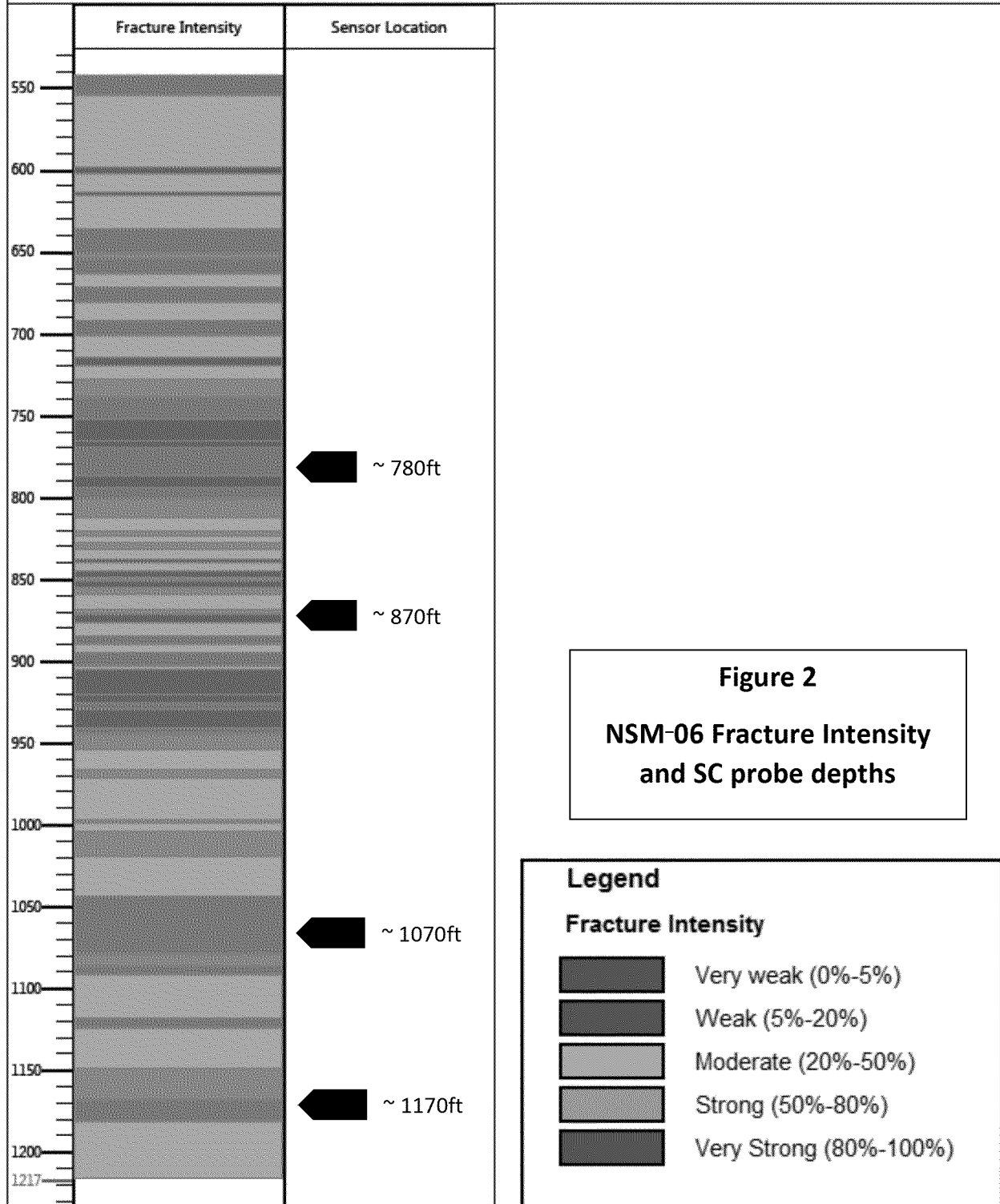
**FIGURE 1**  
**INTERMEDIATE MONITORING WELL**  
**LOCATIONS - CROSS SECTIONS F-G**

# Log Report



**HOLEID:** NSM-006

**PROJECTCODE:** IMW

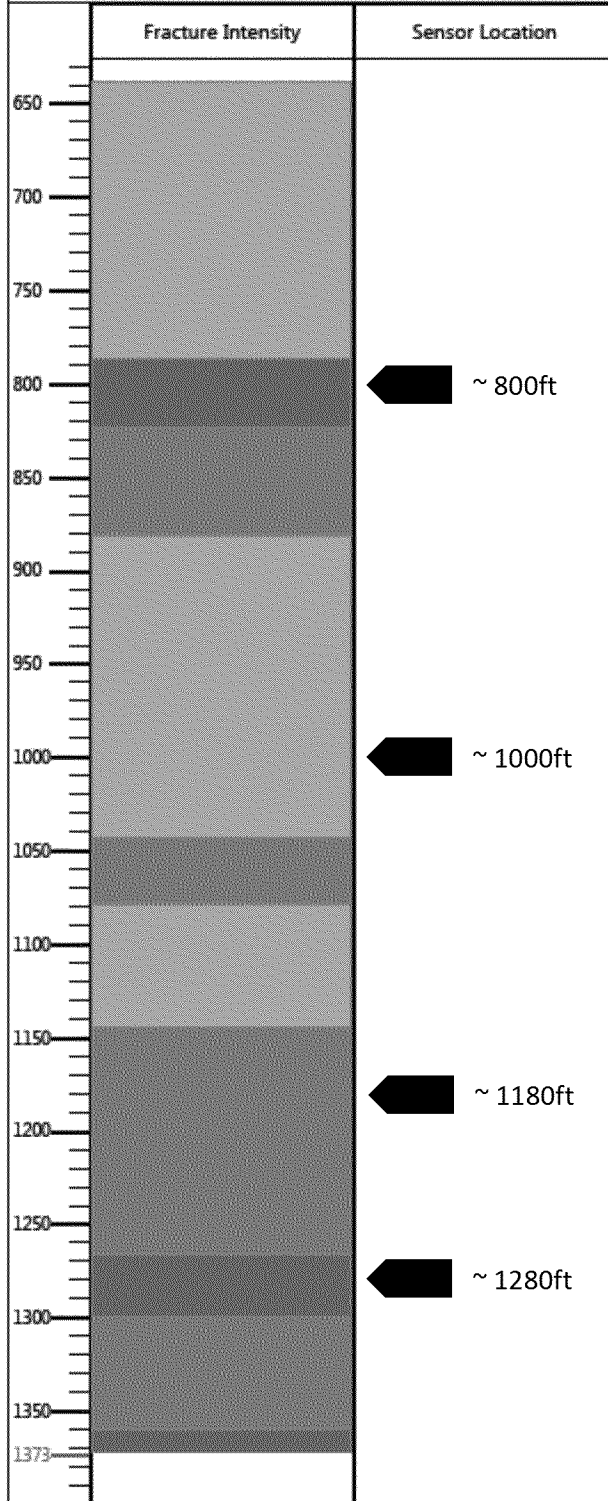


# Log Report



**HOLEID:** NSH-019

**PROJECTCODE:** IMW



**Figure 3**  
**NSH-019 Fracture Intensity**  
**and SC probe depths**

**Legend**

**Fracture Intensity**

- Very weak (0%-5%)
- Weak (5%-20%)
- Moderate (20%-50%)
- Strong (50%-80%)
- Very Strong (80%-100%)

# Log Report



**HOLEID:** NSH-024

**PROJECTCODE:** IMW

